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Blending Arts and Sciences - Gimmick or Necessity?

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Abstract: *The shortage of degree qualified engineers in the UK is well documented. On the other hand the surplus of art and design graduates is growing. Whilst acknowledging the shortage in engineering graduates, there is also the need to recognise the breadth and increased skill level that engineering graduates require. Is it therefore possible to convert some of the excess graduates in art and design to careers in design and development engineering?*

The success of many engineering businesses depends not only on technical excellence but also on understanding of the market needs and the speed of response to this demand. To make this task even harder, businesses are also expected to compete in markets that are open to global competition and are also faced with much more sophisticated consumers. Businesses that are engaged in the manufacture of goods now require a new breed of engineer. These are not only technically competent individuals, but also possess what is known as "soft" or "creative" skills traditionally found in graduates of art and design disciplines.

This paper details an innovative curriculum model offered at postgraduate level to address the 21st century needs of engineering businesses. The paper also details rigorous recruitment tools developed and used for selecting students exclusively from the art and design disciplines.

1.0 Introduction

With the evolution of market driven economies and the need to compete in global markets, many western governments have been calling for companies to become more strategy driven while using design and innovation as a business strategy to realise market advantage. This concern has also extended to the creative industries and the education sector, particularly within design education. In the UK, clear evidence of this can be seen by the publication of high profile reviews such as the Cox Review of Creativity in Business (2005) and the Gower Review of Intellectual Property (2006), both conducted by the HM Treasury; as well as the publication of the UK government's 10 year investment strategy framework in science and innovation by the HM Treasury (2004). More recent evidence includes the publication of the report on the design skills gaps in schools, colleges, universities and the design industry published by the Design Skills Advisory Panel (2007) on behalf of the Design Council, which was compiled over a two-year period with input from some 4,000 designers. The report further indicates that although the UK design sector is respected worldwide, and over the past decade the industry has become the largest in Europe with an annual turnover in excess of £11.6bn, there are serious challenges ahead as well as opportunities. The report indicates that in the new global economy, businesses are no longer competing on costs but also on added value while design is seen as the key component in the creation of desirable products

and services (Boztepe, 2007). The demand for design is predicted to be growing while at the same time going through a rapid change. Traditionally, design is perceived to be delivering products, packaging, graphics and logos, but increasingly companies are now looking to designers to take on more strategic roles to deliver innovation and establish strong brands and developing customer loyalty and ultimately contribute to the intellectual capital of businesses.

British design has an international reputation for excellence which far outweighs its size. However, the design sector has a problem; during the period (2001-2007) turnover fell from £6.7bn to £4.0bn, a drop of 40% (British Design Innovation, 2007).

The year 2007 marked out an all time low with all indices pointing downwards:

- Turnover down 8%
- Employees down 4.9%
- Fee Income down 8%
- Overseas Income down 10%
- London Turnover down 10%

However, over the period (2001-2006), the number of students studying creative art and design, the main feeder for the design sector, has increased by 45% to 156,180. This now represents 7% of the total number of higher education students studying in the UK, and is more than the number studying engineering and technology (Higher Education Statistics Agency, 2007a).

Over the last few years many high profile reports and initiatives have been presented, outlining strategies to reverse the sector's decline (Creative and Cultural Skills, 2005; Keep British Design Alive Campaign, 2006; Cox Review, 2005), but little attention has been paid to the dramatic and unstoppable growth in student appetite for this subject.

RESEARCH QUESTIONS

- What is the size and shape of the design and engineering sectors in the UK?
- What are the constituent parts of design and engineering education in the UK?
- How big are the problems facing design and engineering education?
- What should the correct level of supply of design and engineering graduates be?
- How do you manage student and sector expectations?
- What more can the design and engineering sectors do to support graduates?

OVERVIEW OF THE PROBLEMS

The British design industry is relatively small; the British Design Industry Valuation Survey (2006) puts this figure at 4,500 commercial design firms and 65,000 employees. A recent report by Imperial College's Tanaka Business School (2007) puts this at 12,450 design consultancies and 134,000 designers in 2003-04. The latest Design Council report entitled 'The Business of Design' (2005) added 51,500 design directors and managers to this number, making a total of 185,500 designers. 51% of design consultancies have five or less employees; most are based in and around London (33%); with approximately 50% of the employees working as self-employed (freelance) designers (British Design Innovation, 2006; Labour Force Survey, 2006).

Whatever the true figure, when compared to the rest of the world, the UK has a high proportion of practicing designers; this amounts to roughly a third of the number in the US, and 13 times the number in China (Whyte and Bessant, 2007).

In terms of engineering, the recently published Engineering UK Research Report (2007) has highlighted the challenges faced by UK PLC:

"The need for employers to up-skill their workforces has never been more urgent and the potential payback for investing more in training and workforce development never greater. Policy imperatives are increasingly focused on raising employer ambition and demand for skills, and investing in their management, leadership and HR practices in particular."

NATIONAL STATISTICAL DATA ON THE DESIGN PROFESSIONS

In the UK, industries are classified using the Standard Industrial Classification (SIC) 2003 codes. Due to the diversity of the design sector, there is no single SIC code which corresponds directly to this sector; much of the work in design relates to several codes. This is a profound weakness in the system, and makes it very difficult to accurately measure statistics like %Gross Domestic Product, %growth, exports, employment and business size for this sector.

The Standard Occupational Classification (SOC) 2000 codes classify all UK occupations into nine major groupings and a series of sub-groups, the group which mainly covers the Design Sector is Group 3: Associate Professional and Technical Occupations (see Table 1). The minor group 342: Design Associate Professionals is of particular interest since it contains the main 'designer' categories.

Table 1: UK Employment by Design Occupation
(Labour Force Survey, Quarter 2 (Apr – Jun) 2006)

Major Group	Sub-Major Group	Minor Group	Unit Group	Group Title	Employees
3	Associate Professional and Technical Occupations				4,036,000
	34	Culture, Media and Sports Occupations			612,000
		342	Design Associate Professionals		136,000
			3421	**Graphic designers**	**93,000**
			3422	**Product, clothing and related designers**	**43,000**

In their latest Creative Industries Economic Estimates statistical bulletin (2006), the UK Government Department for Culture, Media and Sport (DCMS) highlighted the problems of accurately defining the size and impact of the 'Creative Industries' due to the necessity to use classifications dictated by international convention. It goes without saying that there are many other types of designers not covered by Table 1 above; these fall into the categories of Architects, Glass and Ceramics, Furniture, Jewellery, Crafts, Artists, Weavers, Photographers, Software, Computer Games, etc. If we include all the Creative occupations as defined by the DCMS, this had been estimated to total 1 million employees directly and another 0.8 million indirectly by the summer quarter of 2005.

NATIONAL STATISTICAL DATA ON THE ENGINEERING PROFESSIONS

The total number of UK based Chartered Engineers (CEng) and Incorporated Engineers (IEng) working and registered with the ECUK in the UK as of January 2007 was 242,530. Of these, 188,701 were CEng, 40,466 IEng and 13,363 EngTech.

The Engineering and Training Board (ETB), the Engineering Council UK (ECUK) and the Professional Engineering Institutions are working to promote registration and increase the number of registered engineers in the UK. In 2007, the ECUK obtained a large matrix of data analysing specific jobs by the Standard Occupation Classification (SOC) codes and by Standard Industrial Classification (SIC) codes. This data was provided by the Office of National Statistics' (ONS) Labour Force Survey (LFS).

Based on these figures, it is estimated that there are approximately 800,000 engineers in the sector. SEMTA, the Sector Skills Council for manufacturing and engineering, estimates the total workforce in SET-related activities is around two million with LFS-based estimates totalling one and three quarter million.

However, the ECUK notes that *"There are no reliable figures to estimate the numbers of people whose title does not include engineering but who practice engineering in the course of their work, such as scientists, technologists, metallurgists, computer programmers, and many more".*

Table 2: UK Employment by Engineering Occupation
(Labour Force Survey, Quarter 2 (Apr – Jun) 2006)

Major Group	Sub-Major Group	Minor Group	Unit Group	Group Title	Employees
2				Professional Occupations	3,685,000
		212		Engineering Professionals	442,000
			2126	**Design and development engineers**	**64,000**
			2129	**Other engineering professionals**	**79,000**

DESIGN EDUCATION IN THE UK

Of the 130 or so higher education institutions in the UK, roughly 25% offer degrees in the main subject area of creative arts and design. This encompasses a number of minor subjects, namely: *Design Studies, Music, Fine Art, Drama, Cinematics and Photography, Imaginative Writing, Dance, Craft and Others*. Table 3 shows the breakdown of these minor subjects. By far the biggest of these is Design Studies, having approximately 39% of the total student body (60,175) by 2005/06. Design Studies is itself made up of Graphic Design, Illustration, Clothing/Fashion, Industrial/Product (3,875), Interior, Furniture, Ceramics and Interactive and Electronic Design.

The 71% growth in Design Studies courses over the last decade in the UK has been spectacular; however, this has not been matched by increases in the number of jobs in the sector. The ratio of practicing designers to students studying design is roughly 2:1.

Around 6,000 people are recruited to the profession every year, compared to approximately 18,000 that graduate (see Table 4). Clearly this imbalance may be good for the design industry, which can pick and choose graduate employees, but is an enormous waste of a useful and talented resource. Much more should be done to manage expectations of prospective design students.

Sir Christopher Frayling, Rector of the Royal College of Art has been recently quoted as saying that:

> *"Regarding the second point – that designers are being over-produced – I don't agree, I believe design is very good professional training for the world of design and good preparation for life. A lot of graduates have not gone into design; the training can be used more widely. The tail wags the dog, as it were, and it wouldn't be said that there weren't enough jobs to satisfy students from other courses, such as History or English, so why say it about design?" (Woods, 2007)*

The trouble with this argument is that unlike History or English, designers are being trained for a specific career. To spend three or more years studying, to then get a job waiting tables must be very disheartening.

So what are graduates of design doing if they can't find work in the profession? Evidence for this comes from a range of sources, one of the most up-to-date being Graduate Prospects (2007). Roughly 35% find work in their chosen profession; almost 19% are working in Retail, Catering, Waiting and Bar Staff; 13% in other occupations and 9% in Clerical and Secretarial occupations (see Figure 1).

63% of art and design graduates interviewed in a 1999 survey were working outside the creative industries (Harvey and Blackwell, 1999). The reality of taking an undergraduate degree in the Arts is that graduates face an average 4% drop in their earnings over a lifetime, compared to those who leave education after A-Levels. It is interesting to note that Engineering graduates have a 20% increase in earnings (Walker and Zhu, 2003).

The latest figures from the Higher Education Statistics Agency (2007b) for employment of graduates shows that approximately 9% of creative arts and design (2005-06) graduates were unemployed. This is the third highest of any subject; only Combined Studies and Computer Science graduates have higher rates of unemployment six months after graduation.

Table 3: All HE students by level of study, mode of study, subject of study, domicile and gender (2005/06)
(Higher Education Statistics Agency, 2007a)*

						United Kingdom			Other European Union			Non-European Union		
	Total HE Students	**FT UG**	**FT PG**	**PT UG**	**PT PG**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**
Creative Arts and Design	**156180**	**123260**	**9210**	**16750**	**6960**	**139130**	**83770**	**55355**	**7475**	**4675**	**2800**	**9580**	**6420**	**3160**
Design Studies**	**60175**	53100	3095	2525	1455	**52205**	31440	20765	**2965**	1895	1075	**5000**	3490	1515
Music	**23460**	16535	1960	3380	1585	**20730**	9295	11440	**1395**	665	730	**1340**	785	550
Fine Art	**20525**	13980	1290	4035	1225	**18755**	13030	5725	**805**	565	240	**965**	655	305
Drama	**19795**	17050	1140	985	620	**18095**	12740	5355	**835**	630	205	**860**	605	255
Cinematics and Photography	**14590**	12105	700	1130	655	**12985**	5780	7205	**805**	415	390	**800**	440	360
'Others'	**6940**	4040	425	1885	585	**6425**	4290	2135	**230**	165	70	**280**	190	95
Imaginative Writing	**5825**	2250	460	2415	705	**5580**	3480	2095	**100**	60	40	**145**	105	45
Dance	**3170**	2850	140	65	115	**2725**	2370	355	**305**	255	45	**145**	120	20
Crafts	**1660**	1315	10	320	15	**1590**	1320	270	**30**	25	5	**40**	35	5

* Data re-ordered in terms of student numbers for clarity.

** In Design Studies for example 86.8% are from the UK, 4.9% from the EU and 8.3% from Non-EU countries.

NB: As of 1 May 2007 under the International Graduates Scheme, graduate students of any recognised degree, UG or PG may stay and work in the UK for up to 12 months after graduation.

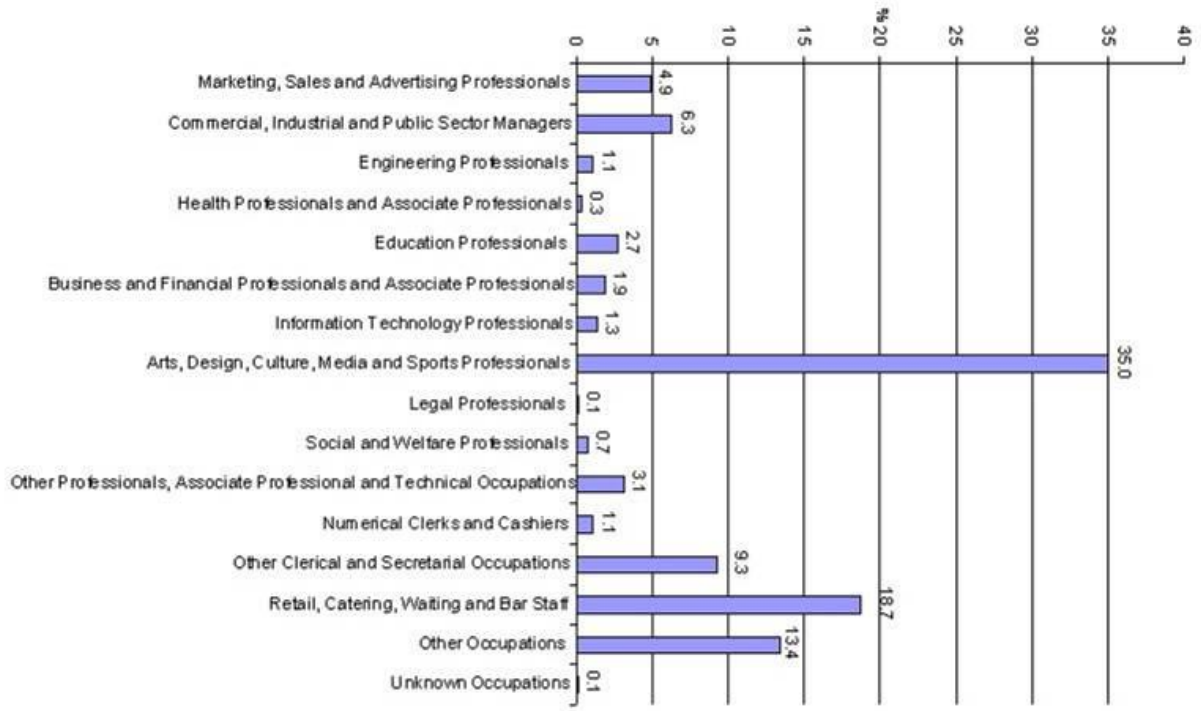

Figure 1: Destination of 2005 Design Graduates (Graduate Prospects, 2007)

There is clearly potential for enormous discontent amongst graduates of design who have invested several years and many thousands of pounds only to find out afterwards that there is little chance of finding work in their chosen profession. The current situation has forced graduates in this field into other less desired professions, such as Retail, Catering, Waiting and Bar Staff.

Engineering education in the Uk

When compared with the explosive growth in design education, engineering has long been seen as stable. Table 4 contrasts the growth in design with the static numbers in engineering.

Table 4: Comparison of UG and PG Degree students in Design and Engineering (HESA, 2007a).

HESA Stats 2005/06 (HESA Stats (2002/03))	TOTAL HE Students	First Degree Graduates	PG Students		PG Graduates
			FT	PT	
Creative Arts and Design	156,180 (132,675)	31,300 (26,465)	9,210 (8,105)	6,960 (5,935)	7,200 (5,190)
Design Studies	*60,175 (53,615)*	*18,100 (15,210)*	*3,095 (2,480)*	*1,455 (1,295)*	-
Engineering and Technology	136,695 (131,575)	19,800§ (19,455)	21,735 (18,185)	17,245 (16,490)	13,200 (7,310)
Mechanical Engineering	*21,955 (21,070)*	*3,016 est. (3,115 est.)*	*2,280 (2,255)*	*1,755 (2,125)*	-

§ The Engineering and Technology sector will need 27,000 professionals per year (2002-12).

A recent report by the Engineering Construction Industry Training Board (ECITB) has recently predicted that this could result in a shortfall of 35,000 people by 2014.

> *"The industry is at a turning point in that the supply of suitably qualified personnel in the UK workforce has tipped into shortage. Demand for people is forecast to rise further, increasing pressure on the labour market. Employment costs are rising rapidly in some disciplines. There is increasing evidence of poaching and European sources are becoming more difficult to access. Business expansion is being compromised by lack of suitable people and future Client investment in the UK is increasingly at risk."*
>
> *(ECITB, 2007)*

Targeted promotion of Design Engineering programmes

Higher education in many parts of the world has traditionally considered arts and sciences in design education as an odd combination and many institutions have avoided this particular mix. Historically, this has been the accepted view; however, today, design educators are at least willing to explore the opportunities that these two, seemingly incompatible, disciplines could offer (Findeli 2001).

Middlesex University were one of the first departments in the UK to recognise the tremendous potential that exists within graduates of design by starting a master's programme in design engineering which aims to convert 'design' graduates to careers in design and development engineering (there are currently 50% more design and development engineers working in the UK than there are product, clothing and related designers – Labour Force Survey, Quarter 2 (Apr – Jun) 2006). This programme is fully-funded by the Engineering and Physical Sciences Research Council (EPSRC) under their Collaborative Training Account (CTA) programme.

This programme, now in its fourth cohort as of Sept 2007, has been highly successful in gaining national recognition from industry bodies such as the Engineering Council (IEng status) and the Institution of Engineering Designers (full accreditation, thesis prize (2006 and 2007) and group project prize (2007)). Working closely with industrial partners such as Ford Motor Co Ltd., Acrobot Ltd, Jeld-Wen Co Ltd, Jaguar-Land-Rover, etc, we are on target to provide design engineering careers to 60 graduates over the four-year cycle. Most of these graduates are now working as design and development engineers in the UK. Although this may appear to be insignificant in terms of size, it is exactly what the higher education providers should be doing to address the issues raised by this paper.

Psychometric Profiling tool

From the initial concept phase of the new MSc programme, it was decided to incorporate a psychometric profiling tool into the selection process. This test battery was developed over several months with reference to tried and tested tools such as the Bennett Mechanical Comprehension Test® (BMCT), the Wiesen Test of Mechanical Aptitude® (WTMA) and The US Air Force Officer Qualifying Test® (AFOQT).

In its final form, the test consists of ten components each designed to test competency in a specific area of work:

1. Verbal Analogies
2. Arithmetic Reasoning
3. Word Knowledge
4. Maths Knowledge
5. Mechanical Comprehension

6. Block Counting
7. Table Reading
8. Drive Belts and Gears
9. General Science
10. Parts Assembly

Each section contains five questions with five possible answers and the total test duration is fifty minutes. To date, the test has been taken by 75 short listed applicants (from several hundred that have applied); the results are as follows:

Table 5: Results of Psychometric Test Battery.

Test No.	1	2	3	**4**	5	6	**7**	8	9	10	Overall Mean
Total Scores of Test Population	274	205	246	**129**	201	250	**362**	256	254	208	64%
Test Mean	188	188	188	188	188	188	188	188	188	188	*SD = 14%*

From the results of the psychometric testing, it can be seen that most of the applicants found the 'Maths Knowledge' test 4 to be the most difficult, as expected. Conversely, they found the 'Table Reading' test 7 the easiest. The mean applicant score to date is 64% with a standard deviation of 14%. The results have been used by the teaching team to focus attention on weaknesses of candidates, particularly in engineering maths. Extra support is therefore provided at the point of need.

This testing method, when combined with a personal interview, has provided the course management team with another useful indicator of the students' ability to convert from the 'design' discipline to the 'design engineering' discipline and has provided a clear differentiator between the best and the worst candidates. The initial screening process provides us with high calibre graduates, those with a first or upper second class degree. This test provides a further aptitude filter – we have never accepted a candidate who score less than 40%.

Future plans involve analysing the data to correlate success in the test with exit profile from the programme, thus providing a predictive tool.

PROGRAMME STRUCTURE

The conversion programme developed at Middlesex University was put forward specifically to address the shortage of design and development engineers in the UK. The programme development involved significant input from several industrial sectors in shaping the structure as well as the content. The programme has a very strong industrial context and is linked to industry through compulsory placement and thesis work.

Although the expected programme outcome is a Masters degree, there are two other exit opportunities for unforeseen circumstances, i.e. a PG Certificate and a PG Diploma.

The programme is divided into three parts, each of three months duration: Engineering Fundamentals, Industrial Placement and Thesis (Figure 2). In part 1, the main effort is delivered through a series of three short but intense modules. These consist of new knowledge development and are delivered back to back over three weeks each. They are supported by two other modules that help contextualise the other three modules. The most challenging module has been the Applied Mathematics module where contextualised delivery

focused on real design problems which ensured student engagement and success. The other supportive module is the integrated Design Project that brings together all of the taught content and is normally based on a problem identified by one of our industrial partners.

Part two of the programme is a placement activity that follows successful progression from part 1. Each of the students are selected by one of the industrial partners for a three month placement opportunity. This is an essential part of the programme where the students are thrown into the deep end and are expected to become familiar with the discipline they are converting into. Although most of them find it hard, the students report that it is also the most enjoyable aspect of the programme.

The last part, Thesis, can take place either at the company or at the University. This has been left to the students and the industrial partners to negotiate but in the past three cohorts, this has been almost on equal bases.

As the industry gets more aware of these new breed of engineers, it is getting harder to keep the students on the programme to completion. Following the placement activity, many are made full-time offers that are becoming very tempting for the students. Although the programme fees are paid by the EPSRC, there is no stipend paid to the students. However, in most cases, the programme team have negotiated an amicable solution to enable students to complete the programme.

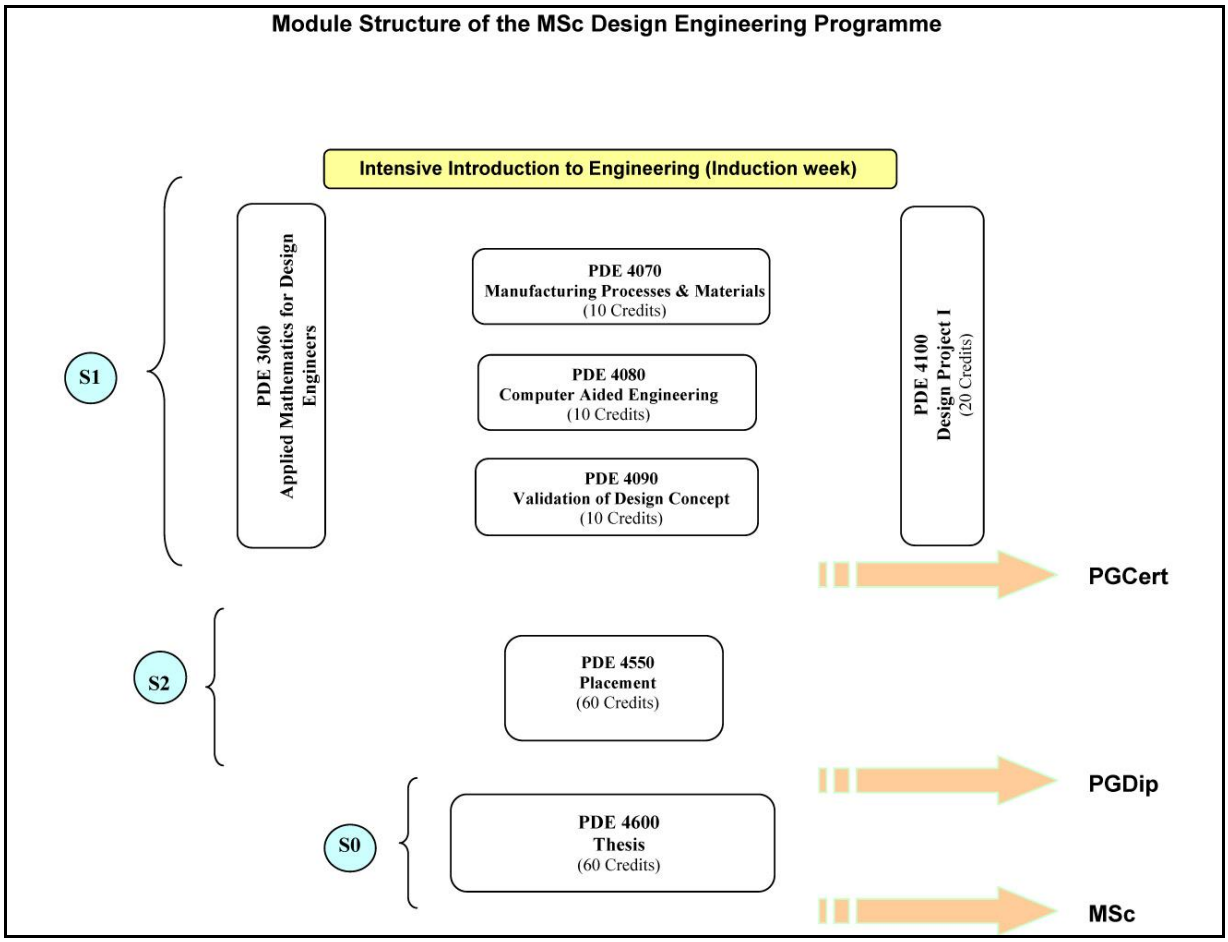

Figure 2: Programme Structure.

Conclusion

The paper presented the changing nature of engineering and how the skills shortage, specifically in design engineering. It offered a solution strategy that capitalises on the oversupply of other relevant sectors largely overlooked by many UK HEIs. It presented an academic structure that has been proven to successfully work and is approved by engineering professional bodies. The paper argues that the HEIs as well as other interested parties need to recognise the changing nature of engineering skills needed and the opportunities offered by cross-discipline approaches as illustrated in this paper. It is also a sobering to take note of the following quotation from the recent report by ETB.

"*The primary example of this phenomenon is the rise of China, which will double its economic size over the next 10 years. Over the last 20 years, its share of the world economy has quadrupled. It is predicted that by 2015 its economy will be as large as that of the US and greater than that of the EU-25. Much of this growth has been achieved through leveraging low wage elements of its economy. In the future it is forecast that this rate of growth will be unsustainable over time and that they will have to concomitantly pursue higher level/innovation skills.*" (Engineering UK, 2007)

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